BORNA DISEASE

Authored by

mohammad looti

November 7, 2025

Borna Disease

Primary Disciplinary Field(s): Virology, Veterinary Medicine, Neurology, Psychiatry

1. Core Definition

Borna Disease (BD) is defined as a severe, progressive, and often fatal viral zoonosis that primarily affects the central nervous system (CNS) of mammals, leading to a condition known as encephalomyelitis. The causative agent is the **Borna Disease Virus (BDV)**, which belongs to the family *Bornaviridae* and the order *Mononegavirales*. BDV infection is characterized pathologically by non-suppurative encephalomyelitis, meaning inflammation of the brain and spinal cord without the formation of pus. Clinically, the disease manifests through profound neurological and behavioral disturbances, making its study relevant not only to veterinary science but also to human neurology and psychology, particularly due to its historical association with mental health disorders. The diagnosis of Borna Disease is challenging due to the variability of symptoms and the difficulty in detecting the virus in peripheral tissues, necessitating specialized molecular and serological techniques.

While traditionally recognized as an equine affliction--causing significant morbidity and mortality in horses and sheep--Borna Disease has gained intense scrutiny in recent decades due to increasing evidence of its **zoonotic potential**, confirming its ability to jump the species barrier and cause severe, life-threatening infections in humans. The virus targets neurons and glial cells, replicating primarily within the nucleus of infected cells, which is a unique characteristic for a non-segmented, negative-sense RNA virus. This neurotropism results in the characteristic clinical syndromes observed across affected species, including profound changes in motor control, sensory perception, and cognitive function, ultimately leading to systemic failure and death in the majority of untreated cases.

2. Etymology and Historical Development

The recognition of Borna Disease dates back to the late 19th century, specifically the period between 1891 and 1892, following a devastating epidemic among cavalry horses in the town of Borna, near Leipzig, Germany. This location lent its name permanently to the disease. Early observations confirmed a highly contagious ailment characterized by severe behavioral changes and high fatality rates among the infected equines. For many years, the causative agent remained elusive, with research focusing on various bacterial and toxicological possibilities, hindering the development of effective prevention and control measures until the viral nature of the disease was firmly established.

The true viral etiology was confirmed through transmission experiments in rabbits and other animals, demonstrating that a filterable agent was responsible for the neurological symptoms.

However, the definitive molecular characterization of the Borna Disease Virus (BDV) did not occur until much later in the 20th century, allowing researchers to place it correctly within the taxonomy of negative-sense RNA viruses. This breakthrough led to the understanding that BDV is an ancient virus, co-evolving with its hosts. A crucial modern development was the identification of the bicolored white-toothed shrew, *Crocidura leucodon*, as a likely **natural reservoir** of the virus in Europe, fundamentally altering the understanding of how the virus persists and spreads geographically. This discovery shifted epidemiological focus from domestic animals as primary carriers to wildlife, highlighting the complex ecological interplay driving BDV transmission.

3. The Borna Disease Virus (BDV): Taxonomy and Structure

The Borna Disease Virus, specifically BDV-1, serves as the prototype species of the genus *Bornavirus*. It is distinct among Mononegavirales (which also includes rabies and Ebola viruses) due to its life cycle. Unlike most viruses in this order, BDV replication and transcription processes occur exclusively in the host cell nucleus. The virion is enveloped, roughly spherical, and contains a non-segmented, linear, single-stranded RNA genome of negative polarity. This genome encodes six major proteins, including the nucleoprotein (N), phosphoprotein (P), matrix protein (M), glycoprotein (G), and a large polymerase protein (L), alongside the regulatory X protein.

The mechanism by which BDV causes neurological pathology is highly complex. The virus exhibits a unique characteristic known as persistence, meaning it can establish a long-term infection in the host without necessarily triggering immediate cell death, unlike highly lytic viruses. Instead, BDV replication often leads to altered cellular function and chronic inflammation, contributing to the development of encephalopathy. The immune response to the virus--specifically T-cell mediated inflammation--is thought to play a major role in the resulting neurological damage, rather than direct viral cytopathology alone. This immune-mediated damage is central to the development of clinical signs, such as **ataxia** and **blindness**, which are characteristic of the later stages of the disease.

4. Transmission and Zoonotic Potential

Borna Disease is recognized globally as a significant zoonotic threat. Transmission of BDV occurs via bodily secretions and excretions, particularly through contact with the natural reservoir host, the shrew. The primary route of infection in both animals and humans is believed to be **intranasal transmission**, often through inhalation of aerosolized particles or direct contact with contaminated materials, such as saliva or urine from infected shrews or other infected intermediate hosts. BDV has also been detected in the blood and other tissues, suggesting potential, though less common, alternative routes of transmission.

In the context of human infection, definitive cases of human Borna Disease (HBD) leading to fatal

encephalitis have been documented, particularly in regions of Central Europe where BDV is endemic in shrews. Prior to these confirmations, human exposure was primarily assessed through serological surveys, which indicated that a significant percentage of the human population had antibodies against BDV, suggesting widespread, subclinical exposure. However, the identification of acute, lethal HBD cases definitively linked BDV-1 transmission from shrews to humans confirmed the seriousness of the infection, prompting intense public health interest. These findings necessitate rigorous biosafety protocols when handling wild rodents in endemic areas and underscore the need for increased surveillance of severe, unexplained encephalitis cases.

5. Clinical Manifestations and Pathology

In its primary mammalian hosts, particularly equids, Borna Disease progresses through distinct clinical phases. The initial phase may be subtle, marked by non-specific signs such as fever and malaise. This rapidly progresses to the neurological phase, where the hallmarks of encephalopathy become apparent. These clinical manifestations include profound behavioral changes ranging from lethargy and depression to severe excitability, aggression, and **mania**. Animals may display compulsive behaviors, impaired coordination (ataxia), head pressing, and an abnormal gait.

As the infection advances, the damage to the CNS becomes widespread, resulting in motor deficits, cranial nerve dysfunction, and often complete blindness. The disease course is typically acute to subacute, with clinical signs worsening rapidly over days or weeks, frequently culminating in paralysis, coma, and ultimately **death**. Post-mortem examination consistently reveals the characteristic pathological signature of BD: perivascular cuffing (immune cell accumulation around blood vessels) and non-suppurative inflammation within the gray matter of the brain. The detection of inclusion bodies, known as Joest-Degen bodies, within the nuclei of infected neurons, serves as a classic histological marker for the disease, though modern diagnosis relies more heavily on PCR and immunohistochemistry.

6. Historical Association with Human Psychiatric Disorders

For several decades, Borna Disease held a contentious position in psychiatric research. Due to its known ability to cause dramatic behavioral disturbances in horses and its neurotropism, BDV was hypothesized to be a potential underlying etiological factor for certain severe human psychiatric illnesses, including **schizophrenia** and **bipolar disorder**. This hypothesis was supported by early serological studies in the 1990s that reported a higher prevalence of BDV antibodies and viral RNA segments in the peripheral blood mononuclear cells (PBMCs) of psychiatric patients compared to healthy controls.

However, these findings proved highly controversial and difficult to replicate consistently across different laboratories and geographic regions, leading to intense scientific debate. While some

research suggested a correlation between BDV exposure and mood disorders, the lack of definitive viral evidence within the brains of psychiatric patients and the inconsistencies in seropositivity results led many researchers to dismiss BDV as a major cause of common human psychiatric illnesses. The eventual confirmation of BDV causing acute, fatal encephalitis in humans (HBD) shifted focus away from chronic psychiatric involvement and towards the immediate public health threat of severe acute infection. Current consensus holds that while BDV causes deadly neurological disease, its role, if any, in chronic, non-fatal human mental illness remains highly speculative and unproven.

Further Reading

Borna disease (Wikipedia)
Centers for Disease Control and Prevention (CDC) - Bornavirus Information
National Institutes of Health (NIH) - Research on Bornaviruses and Zoonotic Potential